

SEVENTH ANNUAL JOHN H. CHAFEE MEMORIAL LECTURE ON  
SCIENCE AND THE ENVIRONMENT

February 1, 2007

# Climate, Poverty *and* Health

TIME FOR PREVENTIVE MEDICINE

Larry Brilliant, M.D., M.P.H.

Founder, Seva Foundation and  
Executive Director, Google.org



National Council for Science and the Environment  
*Improving the scientific basis for environmental decisionmaking*



**The National Council for Science and the Environment (NCSE)** improves the scientific basis of environmental decisionmaking through collaborative programs with diverse communities, institutions, and individuals.

The Council works for a society where environmental decisions are based on an accurate understanding of the underlying science, its meaning and limitations, and the potential consequences of action or inaction.

While an advocate for science and its use, the Council does not take value positions on environmental outcomes and is dedicated to maintaining and enhancing its reputation for objectivity, non-partisanship, and achievement. The Council has programs in five strategic areas (for details please visit [www.NCSEonline.org](http://www.NCSEonline.org)).

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*Sponsored by the*  
National Council for Science and the Environment (NCSE)

*Presented at the*  
7th National Conference on Science, Policy and the Environment  
Ronald Reagan Building and International Trade Center in Washington, DC

February 1, 2007

This volume is the seventh in a series of books documenting the annual  
John H. Chafee Memorial Lecture on Science and the Environment.

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ISBN 0-9785190-2-7

For citation purposes, please use:

Brilliant, Larry, 2007, **Climate, Poverty, and Health: Time for Preventive Medicine**.  
Seventh Annual John H. Chafee Memorial Lecture on Science and the Environment.  
Washington, DC: National Council for Science and the Environment.

This volume is the seventh in a series of books documenting the annual John H. Chafee Memorial Lecture on Science and the Environment. The lecture was delivered at the 7th National Conference on Science, Policy and the Environment: Integrating Environment and Human Health (David Blockstein, Conference Chair) on February 1, 2007, in Washington, DC.

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Printed with Eco-ink (low-volatility vegetable oil-based ink)  
on 25% post-consumer recycled paper using 100% wind energy  
in a carbon neutral process.

Manufactured in the United States of America.

The National Council for Science and the Environment is grateful to the following sponsors for making possible the Seventh Annual John H. Chafee Memorial Lecture on Science and the Environment

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DEDICATION



*This book is dedicated to the memory of Senator John H. Chafee who, in his 23 years representing Rhode Island in the U.S. Senate, was a leader in promoting a bipartisan, science-based approach to environmental issues.*



*Top: NCSE President Ambassador Richard Benedick, Georgia Chafee Nassikas, and former Senator Tim Wirth thank Dr. Larry Brilliant for delivering the Chafee Lecture.*

*Above right: NCSE's Executive Director, Dr. Peter Saundry, introduced Dr. Brilliant and commended him on his life's achievements.*

*Above left: Participants at NCSE's 7th National Conference on Science, Policy and the Environment: Integrating Environment and Human Health*





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## DR. PETER SAUNDRY

Executive Director, National Council for Science and the Environment

**Richard Benedick:** Ladies and gentlemen, a traditional high point of the annual national conference is the John H. Chafee Memorial Lecture. The list of past Chafee lecturers speaks for itself: Nobel Laureates Sherwood Rowland and Mario Molina; Pulitzer Prize recipients E.O. Wilson and Jared Diamond; Rita Colwell, then Director of the National Science Foundation and now a member of the NCSE board; Bill Ruckelshaus,

who was the first administrator of the Environmental Protection Agency and also the fifth; and last year, Ralph Cicerone, President of the National Academy of Sciences. This year, we have another, dare I say, brilliant addition to this list. I'm sure it is the first time you have heard that. I would like to call on to introduce our Chafee lecturer, Peter Saundry, the indefatigable Executive Director of the National Council who is the real motor behind our daily work and our daily and annual accomplishments. It is my pleasure to turn to Peter Saundry.



**Peter Saundry:** I'll be brief, because I know you all are eager to hear what Larry has to say, so let me just tell you a little bit about him.

Preparing this introduction was actually kind of fun, because it was a little bit like reading a movie script. The movie that comes to mind—I hope you will not get offended by this Larry—is *Forrest Gump*. Not that he has any similarity to Tom Hanks' character, but Larry has this sort of innate ability to be around at iconic moments at just the right time.

Take a look at his background. When Larry's father suffered from cancer, he went into medicine. And just as he was getting ready to start a rather traditional career as a surgeon, a group of Native Americans occupied Alcatraz Island.

I'm not quite sure how, but Larry was recruited into going to the island to help deliver a baby and ended up becoming a spokesman for Native American rights, which led him into a movie part playing a hippie doctor, which may be appropriate. Which got him nothing but a ticket to India and a spell on an ashram in North India where he picked up a very useful skill:



He speaks Hindi. And I know from this afternoon's conversation, he is still fluent in it. But he had, I think, a very practical guru who sent him down to work for the United Nations on smallpox eradication just at the time when Indira Gandhi was opening up India to that process. He says he was just a mascot for the program, but after a time, Larry and his team from the World Health Organization succeeded in eradicating small pox from India, and from the world.

When he returned to the United States, he picked up a Masters in Public Health, served a stint as a professor at the University of Michigan, and established the Seva Foundation, which has essentially cured blindness for two million people in Asia through surgery and a number of other procedures.

He tried to recruit a young computer whiz to give up what he thought was a foolish company at the time to come and run Seva. Fortunately, perhaps, Steve Jobs told him no and went on to change the world with Apple Computer. But it seems Jobs probably taught Larry a few things about IT, because Larry started to set up IT companies and he has done extremely well in that, forming, well, the WELL. I do not know if you remember WELL. It is still around, I think, as the Whole Earth 'Lectronic Link, sort of an online community, one of the first and perhaps one of the longest lasting. He then went on to form a number of other companies, such as SoftNet.

On the side, he managed to keep his hippie roots, I guess, by holding—from what I understand—sort of a part-time role as doctor to the Grateful Dead. I'm sure there are a lot of Deadheads who probably would treat him very well. And having done all these wonderful things, he finally, in what I think is an iconic moment for our generation and for the modern world, became head of Google.org.

Now, finally onto Google.org. The mission, as I can see it, seems to be “do good,” which is not a bad mission. They are focusing on climate change, global public health, and global poverty. I know from our conversations this afternoon that Larry thinks big, and we can expect very big things out of that enterprise going forward. There is a line in the Bhagavad Gita which seems to have a lot of special resonance for Larry and I think it has a lot of resonance here today; and that is, “Live your life without ambition, but live as those who are ambitious.” It seems somewhat contradictory. It really is about how you strive for ambitious



goals because those ambitious goals are worth undertaking—not because you yourself are important or because you want to be famous, I think, but because of the goal itself. And that seems to be, to my mind, very resonant with why we are here today.

I think most of you spent the afternoon putting out ideas that are extremely ambitious, ideas that we hope can change the world for the better. It is not that one idea is a magic silver bullet, but these ideas collectively can begin to turn this supertanker of a world slowly, slowly, slowly but continuously in the right direction towards a better world. We have just heard two examples of how two people, NCSE Lifetime Achievement Award recipients Theo Colburn and Herbert Needleman, have really made profound contributions to doing that. They are an inspiration to us all. So, it seems appropriate that we should then think of that mantra. Which is, I think, appropriate to think about here in this town—because here, the highest hopes of mankind work hand-in-hand with the deepest cynicism of man.

Reality makes us very cynical. For those of us who watch politics, you stay around long enough and you can get very, very cynical. And if you look around at the things that are going on around the world it is easy to get very, very depressed. And yet, we can, I think, constantly inspire ourselves to get up in the morning and struggle to do something worthwhile. And that is what Larry Brilliant's career has been about, and that is what he is endeavoring to do. I think for the next hour, he is going to illuminate us on that very subject. So Larry, thank you very much for coming.

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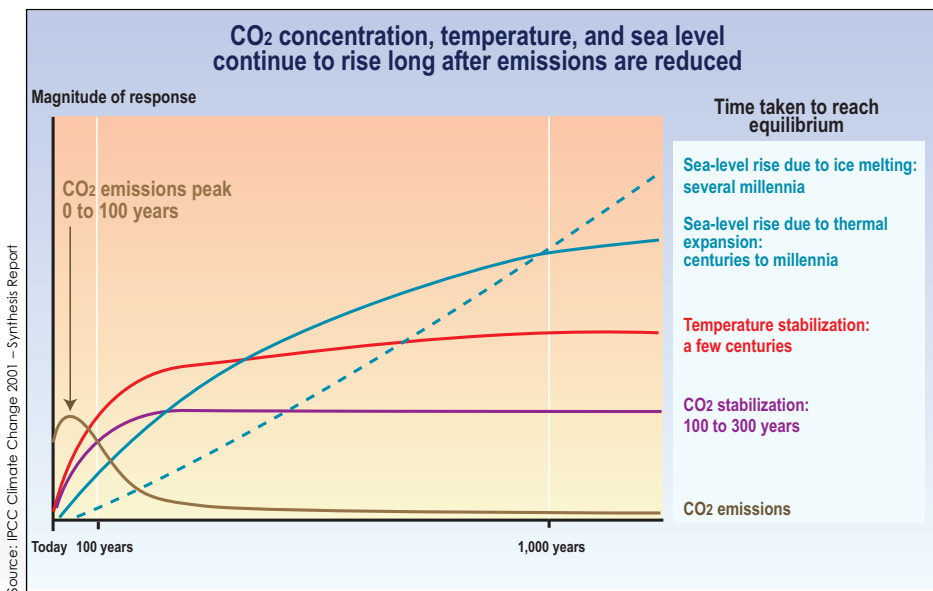
# Climate, Poverty and Health

JOHN H. CHAFEE MEMORIAL LECTURE ON SCIENCE AND THE ENVIRONMENT

Dear Senator Chafee, members of the Chafee family, friends and colleagues: Thank you for giving me the opportunity to be with you this evening and to present the Seventh Annual John H. Chafee Memorial Lecture on Science and the Environment sponsored by the National Council for Science and the Environment.

I particularly want to thank you for coming to listen to me, since most of you know much more than I do about climate change. That puts me in a terrible spot. One never wants to

face an audience that knows more than you! But not only do I face an audience that knows more about climate change, what about the previous six Chafee lecturers? As I read through these historic lectures and marveled at their authorship—it has both humbled me and inspired me. Thank you for giving me a chance to follow such



an all-star lineup of deep thinkers on the issues of science and the environment.

Fortunately for me, the theme of this year's conference is integrating environment and *human health*, so at least I have a chance to make a contribution on the latter side of that equation. But I can tell you that these two worlds—health and the environment—are not always the best of friends, and they will need a lot more integrating in the coming years.

I was in Davos, Switzerland, last week at the World Economic Forum's annual meeting, and I attended many meetings on global health on one day and many others on climate change the next day. I did not see a single other soul who attended both sets of meetings. The fields are inexplicably segregated, even as the subjects are inextricably linked.

Coming from epidemiology and preventive medicine, the 2001 Intergovernmental Panel on Climate Change's (IPCC) Synthesis Report's analysis on the time to reach equilibrium after the reduction in CO<sub>2</sub> emissions was very instructive. The graph (above) suggests that



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global warming, and especially the rise in sea level, are what we would call “lagging indicators” of climate change.

We may learn more tomorrow when the next IPCC report is released, but most of my climatologist friends tell me they think that a certain amount of global warming—say between two and three degrees Celsius—is unavoidable, locked in as it were from the sins of our past. And an even greater disproportionate rise in sea level is also locked in, so that even if we stopped carbon emissions today, we will still suffer from its effects for years to come. But this chart only shows what would happen in later years to sea levels. We need a similar analysis of what would happen to climate-accelerated diseases like malaria and the newly emergent zoonoses—diseases that “jump” from animal hosts to humans—and what will happen to the water and land inundated by salt water. One thing is clear: equally unavoidable effects on health and welfare as a direct consequence of global warming are already locked into our future.

Tonight, then, I want to discuss with you some of these probable “locked in” health and welfare effects of climate change as if a legacy from the sins of our past. Some of them you will either know or already intuit. For example, a litany of new communicable diseases will emerge. We’ve seen many of them recently: zoonoses like bird flu, SARS, monkey pox, and West Nile virus. But old adversaries like malaria will resurge, putting billions of additional people at risk.<sup>1</sup> And as rising seas impinge on coastal communities, making lands uninhabitable, it will create refugees in nearly every continent. Salt will become a new reality to deal with in agriculture as sea waters flood agricultural lands, leading to diminished harvests.<sup>2</sup> In many places water will become contaminated with salt, reducing available drinking water even as our thirsty and hungry population is on course to increase beyond the nine billion mark before it levels off.<sup>3</sup>

There is still time to act—but we are in the stage that my profession calls “secondary prevention,” climatologists call “adaptation,” and economists call “risk mitigation.” By whatever name we call it, we need to think together tonight and for the future of how to make decisions that will minimize the pain and suffering of our brothers and sisters, and especially the poorest and most vulnerable amongst us.

As I look around this room and see leaders from so many walks of life, I share with you the most difficult challenge: decisionmaking under conditions of uncertainty. How much global warming? What is the timeline for climate change? How much rise in sea level? These



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are the uncertainties. But I can tell you that prudence dictates we now must plan for the health and welfare consequences of these changes because we know, directionally and qualitatively, what they will be.

In my field of preventive medicine, we identify primary, secondary, and tertiary prevention as distinct from disease treatment. Not to put too fine a point on it, but primary prevention measures are “those intended to prevent the onset of a condition,” including things like vaccination that literally prevent disease.<sup>4</sup> Secondary prevention usually consists of those

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*What are the remedies to climate change, and indeed how much will they cost—and what is the cost of doing nothing at all?*

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things that prevent disease for people who are still asymptomatic but who have already developed preclinical disease—much like our earth today. In these patients are incubating disorders, similar to the situation with global warming, in that the stage is set, the process of warming—or of disease—is cooking or incubating, but

is not clinically apparent.<sup>5</sup> Screening tests followed by disease mitigation are examples of secondary prevention. Early detection and early response can ameliorate the natural history of disease and minimize suffering.

We can argue semantics, but we agree that we face warming of two to three degrees, sea level rises of many inches or perhaps feet, and health and welfare consequences that we need to better understand.<sup>6</sup> We are in the area of secondary prevention, already beyond the least expensive remedies and into more costly, more dangerous, and less effective preventive interventions. And that is what I want to explore with you tonight: What are these remedies, these secondary preventive measures, and in what venue do we discuss the most controversial of them, in what forum do we debate the costs and benefits, and indeed how much will they cost—and what is the cost of doing nothing at all?

As Dr. Jack Geiger, then of Tufts Medical School and one of the founders of Physicians for Social Responsibility, was quoted as saying “The poor are likelier to be sick. The sick are likelier to be poor. Without intervention, the poor get sicker and the sick get poorer.” Today he might add: “The poor get sicker and the sick get poorer, and as the climate crisis deepens, without intervention, there will be many more sick, and many more poor.”





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And with that in mind, I am not talking to you on behalf of Google.org or the Seva Foundation, I am talking to you out of my experience as a doctor, an epidemiologist and a specialist in preventive medicine, to offer some suggestions for ways to prevent the worst consequences of climate change. But a fair warning: Some of the things we need to consider are bitter pills, hard medicine. I myself do not ideologically like a lot of the medicine I prescribe. As a late-blooming environmentalist, I wish my conclusions were different. As a scientist, I wish the data were better, the conclusions more evident. As a wannabe social philosopher, I wish we could, any of us, think our way out of our current dilemma.

## BANGLADESH: THE CANARY IN THE COAL MINE

Let me start off with a country where I lived for a short time thirty years ago. Bangladesh was the country with the last case of smallpox (*Variola major*) in nature, a young Bangladeshi girl named Rahima Banu, who developed a classic smallpox rash on October 17, 1975.

I was fortunate enough to be part of the successful World Health Organization (WHO) smallpox eradication program and to visit Rahima Banu on Bhola Island just as she was recovering. At some metaphysical moment, when she exhaled the last smallpox virus out of her lungs or when the last virus fell from her scabs, because there were no susceptible hosts to continue the chain of transmission, the *Variola* virus died harmlessly on the Bangladeshi soil. Thus ended a chain of transmission for a disease which began thousands of years ago, killed more than half a billion people in the 20th century alone, and was now eradicated. Bangladesh was not an unlikely place for the mixed distinction of being the last country with *Variola major*. It is a very difficult place to live.

But since then, there has been some good news out of Bangladesh. Now that he has won the Nobel Peace Prize, everyone knows Mohammed Yunus, and most of you know the history of his Grameen Bank. Certainly it is one of the great success stories in economic development. Just under 25 years ago, after leaving Vanderbilt University, Yunus started the Grameen bank (which means “villager’s bank” in Bengali). Over the past 25 years, it has lent money to nearly 6 million in Bangladesh, nearly all of whom are women, with a nearly perfect loan recovery rate. Millions in Bangladesh have been given a loan and hope. And speaking of hope, one of Yunus’ hopes is that over the next 100 years, the Grameen Bank will reach every corner of Bangladesh and provide self help to every Bangladeshi.



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But Yunus' dream and the growth of the Grameen Bank are on a collision course with global warming. Bangladesh has a population of nearly 150 million, the majority of whom live at or just above sea level. For that reason, Bangladesh is one of the countries that would be hardest hit by even small rises in sea level. It is ironic to call Bangladesh "the canary in the coal mine" of course, because unlike the original canaries, which were used to test coal mines for toxic gases, this new "canary" will be affected by coal itself! If coal and other fossil fuels continue to be burned in quantities sufficient to contribute to global warming and thus sea level rise, its coastal communities will be inundated.

Millions have died over the previous century from floods. Bangladesh has such high population densities in coastal communities that almost anything that causes a rise in the seas would be a catastrophe. Indeed a 2000 study by the World Bank suggested that a one-meter rise in sea level, in addition to the devastation of physical infrastructure, would flood half of Bangladesh's riceland with saltwater.<sup>7</sup>

I would like to tell a story about our canary, Bangladesh. A story of how deforestation "upstream" in Nepal followed by erosion and Himalayan melts led to floods that had a devastating effect on this downstream country.

Two major factors literally changed the landscape of the region. Regime change in 1950 effectively opened central Nepal to immigration. This political change was followed by an aggressive malaria eradication campaign throughout the heavily forested tropical area of southern Nepal, which had served as a barrier to invaders. The result of these forces was a near tripling of the population within a single decade, while malaria was officially declared eradicated from Nepal in 1960.<sup>8</sup> To support the rapidly expanding population, however, almost two-thirds of Chitwan's forests were cleared for agriculture.

This deforestation significantly contributed to natural disasters in the monsoon season—with severe soil erosion, landslides, and floods affecting populations downstream. In the Gangetic plain of India and Bangladesh, thousands of people each year are reported to be killed by floods alone.<sup>9</sup> Tens of thousands of cubic meters of topsoil are washed away into the swollen rivers and streams and deposited into the Bay of Bengal.

With global warming, these natural disasters will come at such a scale that thinking of it overwhelms me—as you all know so well, increasing global temperatures are causing the thermal expansion of sea water and the melting of icecaps. Donald F. Boesch of the University of Maryland Center for Environmental Sciences has estimated that for each millimeter rise in



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sea level, the shoreline is swept away an average of 1.5 meters. If sea levels rise by one meter, Bangladesh's coastline could retreat by 1,500 meters, or nearly a mile.<sup>10</sup>

If we don't mitigate the effects of global warming, Mohammed Yunus' hundred-year goal may be washed out, literally. Without food, without land, Bangladeshis would be forced to migrate by the millions. Will their Hindu neighbors graciously accept these millions of Muslim climate refugees?<sup>11</sup>

And it won't be only Bangladeshis who are at such risk. Currently 46 million people around the world are at risk due to flooding from storm surges. With a 50 centimeter sea level rise, that number will increase to 92 million. Raise sea level one meter, and the number of vulnerable people becomes 118 million. A recent study for WHO by scientists at the University of Wisconsin takes those numbers even higher, suggesting that flooding as a result of coastal storm surges could affect the lives of as many as 200 million people by the 2080s.<sup>12</sup>

A one-meter increase in sea level will be enough to flood one percent of Egypt, six percent of the Netherlands, 17.5 percent of Bangladesh, 30 percent of Shanghai, and 80 percent of the Majuro Atoll in the Marshall Islands.<sup>13</sup>

Whatever variable you examine—drinking water, floods, crop yields, nutrition, malaria—the effects of climate change on human health are expected to devastate poor countries, tip countries at the margin into poverty, and wreak social and economic havoc on even the very richest amongst us.

Let's take safe drinking water. Today, 1.2 billion people worldwide lack access to safe water, 2.5 billion lack proper sanitation, and five million die each year from waterborne diseases.<sup>14</sup> By 2025, with current climate projections, it is expected that the percentage of world population living in countries under water stress will increase from 34 percent to 63 percent.<sup>15</sup>

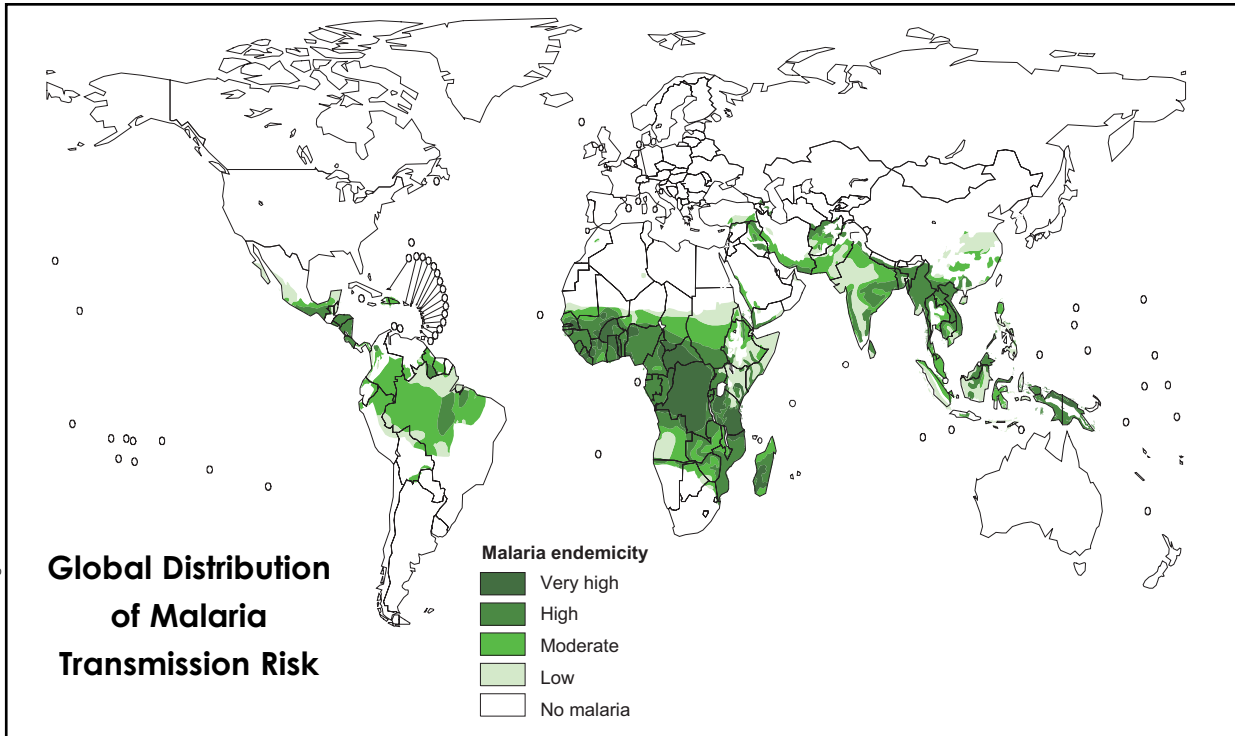
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SOURCE: World Health Organization, 2003

A report from the World Wildlife Fund (WWF) estimates that with an increase of two degrees of warming, an additional three billion people will not have access to adequate drinking water, and with three degrees of warming, the number at risk increases to as many as 3.5 billion.<sup>16</sup>

In addition, competition between drinking water and agriculture is already intense. It will grow more so. Agriculture consumes about 70 percent of the world's available water, but experts predict that small farmers will be the first to lose their supply where there are competing demands for water.<sup>17</sup> The world's poorest rely on their ability to grow crops for their own food supply: estimates are that nearly 1 billion are chronically undernourished, 95 percent in developing countries. Climate change will make it worse.<sup>18</sup> In a study by two scientists in India, a two-degree Celsius rise led to a decline in irrigated wheat yields ranging from 37 percent to 58 percent.<sup>19</sup> This is a huge loss of food in countries already under stress of food shortages, yet this crisis will be even compounded as the world's water supply becomes salty as a result of sea level rise.

The bottom line: The climate crisis is predicted to contribute to a doubling of the number of people without adequate food and water, with the highest burden on the most vulnerable amongst us. This makes it the greatest health crisis of all time.

Jack Geiger was right: the poor get sicker, the sick get poorer.



## CLIMATE CHANGE, MOSQUITOES, AND MALARIA

In 1968, smallpox was the fourth disease considered for eradication by the World Health Assembly, the decision-making body of the WHO. Three previous efforts at disease eradication had already failed: malaria, yellow fever, and yaws (a tropical bacterial infection affecting children). Two of these, malaria and yellow fever, are mosquito-borne diseases. We have never eradicated a mosquito-borne disease. Attempts to eradicate yellow fever were abandoned when it was learned that monkeys could contract the disease and form an animal reservoir for the pathogen.<sup>20</sup> The global malaria eradication program was making progress until the mid-1960s, when DDT was banned—a delicate subject to address in a room full of environmentalists, but one that I will address more later.

Malaria is the worst mosquito-carried killer, causing an estimated 1.5 to two million deaths per year. Malaria contributes the highest percentage (more than 80 percent) of the climate-related disease burden in Africa.<sup>21</sup> The physiological relationships among climate, vectors, and pathogens are only partially understood. Malaria provides a good example of how potential climate change may affect environmental and vector-borne diseases. According to Guerra and Snow, et. al., in 2005 there were three billion people at risk of malaria, mostly from *P. falciparum* and *P. vivax*.<sup>22</sup> That means that approximately 45 percent of the world's population is within the zone of malaria transmission today.<sup>23</sup>

Mosquitoes are hot weather insects that have fixed thresholds for survival.

Climate changes affect malaria prevalence in three ways:

- Extending the range in both latitude and altitude;
- Extending the seasonality (e.g., six to nine months in Kwazulu-Natal); and
- Rapidly increasing after extreme weather events (e.g., rates went up fivefold after 2000 floods in Mozambique; clusters expanded in the Horn of Africa after flooding in December and January).

With a climate change of two degrees, nearly one billion more people—15 percent of the world's population—will be brought into the susceptible zone, bringing the percentage of the world's people within the susceptible zone to 60 percent, or nearly four billion people.<sup>24</sup> In 2005, there were roughly 300 million cases of malaria per year, of which 1.5 to 2 million resulted in death, mostly in children and mostly in Africa.<sup>25</sup> This is likely to increase substantially.

If global temperatures were to rise four degrees Celsius, according to WWF,<sup>26</sup> the impact could be an additional 50 to 80 million cases of malaria worldwide each year. But it does not

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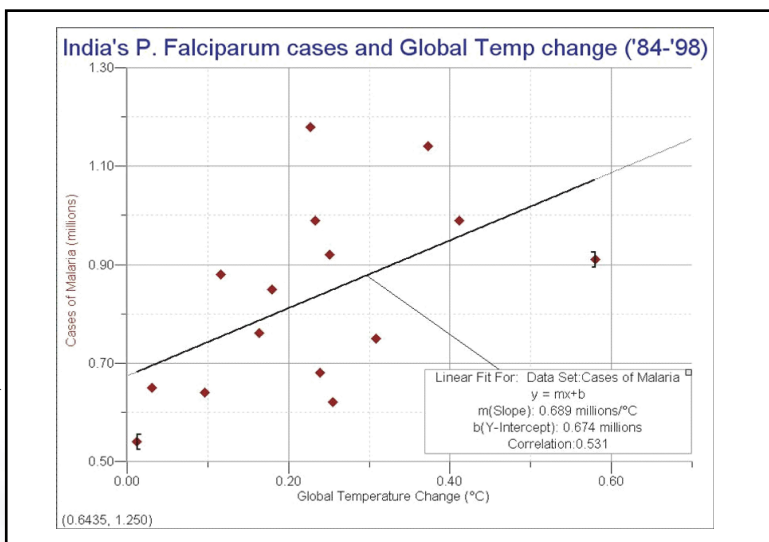
take anything as dramatic as a two- or four-degrees-Celsius increase to cause an increase in malaria; even light warming may contribute to malaria resurgence due to a phenomenon known as “biological amplification.”

To summarize, climate change will alter the prevalence of malaria in the near future. Will it also alter the priority we give to this ancient scourge? Malaria is the weakest of the three sisters of the Global Fund, after HIV/AIDS and tuberculosis. But when as many as 60 percent of humanity live in malaria-endemic areas and deaths double, will we look at it differently?

Today, any talk of “eradication” of malaria is met with some derision; everyone says the costs are too high, the tools are too few. We must plan for a world dominated by malaria if we are not willing to raise the E word—eradication. And how much malaria will it take before we look again at the pesticide poisons like DDT? If we wait long enough, that day may come.

I said in my opening remarks that the environment and health—or rather the ardent environmentalist and the

practitioner of public health—have not always been the best of friends. One poignant story about this revolves around the malaria eradication program in South Asia, which by all accounts had achieved terrific results using DDT to kill off the mosquito vector. Malaria was declared eradicated in Nepal in the 1960s as previously discussed. India was close to eradication, but not as close as Sri Lanka, which was down to a reported 17 or 18 cases in the mid 1960s just as Rachel Carson’s *Silent Spring* alerted environmentalists to the dangers of DDT. This is hugely a controversial topic—even the dates and times and facts are in dispute. But the U.S. Agency for International Development (USAID) pulled funding from the use of DDT, and malaria soared in Sri Lanka until it reached as many as two million cases a year.<sup>27</sup> This is not to simply say that we should blindly bring back DDT, as resistance to its efficacy is now an issue; however, we have two stories: malaria eradication in Nepal contributing to deforestation and then to floods in Bangladesh, and a ban on DDT contributing to a resurgence of malar-



SOURCE: Jones, Kakkilaya, 2006



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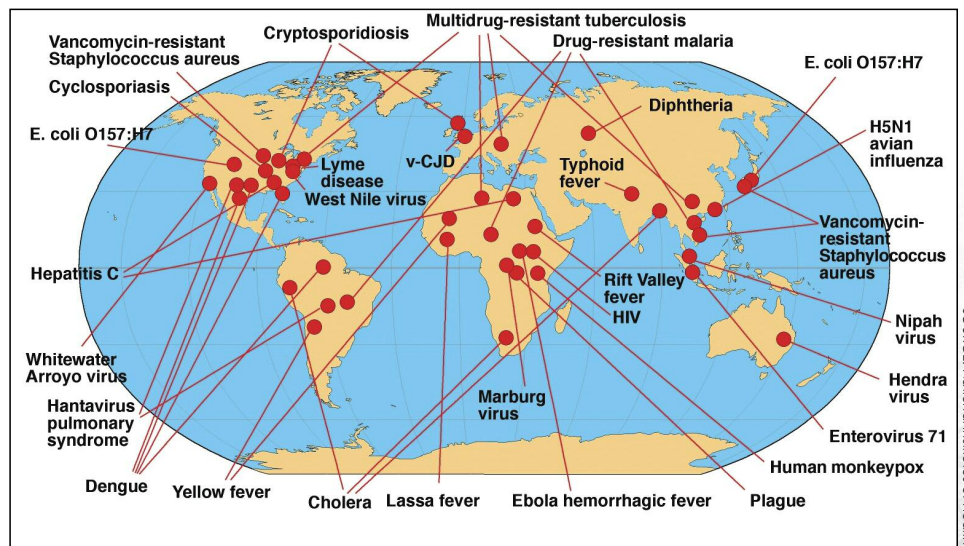
ia in Sri Lanka and elsewhere. We need to study these cases to learn well the lessons of unintended consequences.

## CLIMATE CHANGE AND INFECTIOUS DISEASE

Humans today are pushing every conceivable ecological boundary. We are displacing animal habitats, importing non-native species when we move or migrate, feeding meat products to herbivores, dining on exotic predators, and experimenting with animal hybridization, xenotransplantation and precursors to bio-terrorism in a world made smaller by staggering advances in transportation and global commerce.

In the early 1900s the top 10 killers in the United States were infectious diseases. Since then the United States has gone through the “epidemiologic transition,” a change in the pattern of disease from waves of infectious epidemics to death in old age from chronic diseases caused by genetic roulette and “lifestyle illnesses” such

### Thirty Emerging Communicable Diseases



SOURCE: National Institutes of Health

as over-consumption. One unintended consequence of this transition is that we have ceased our society’s realization of the priority of public health and infectious diseases and have forgotten that humans are only one species of many sharing a rich and effervescent viral stew.

Now, in rapid succession, come torrents of emerging infectious diseases called “zoonoses,” or diseases that “jump” from their usual animal hosts to humans. SARS, mad cow disease, and monkeypox are newly emergent zoonoses, as are Ebola, Marburg, Lassa fever, hantavirus, and almost certainly the HIV/AIDS virus.

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We are obviously and legitimately worried about pandemic flu today, in 2007, but it is a single pixel on a very large canvas. The pressure of the world's population, which has grown from 1.6 billion in 1900 to more than 6.5 billion today, led to human settlements in areas that

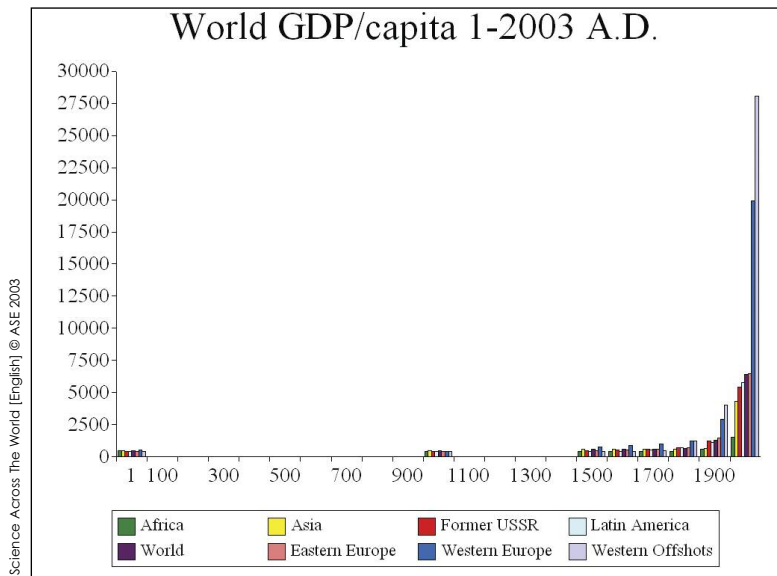
were once jungle habitats.

The way we raise poultry, beef cattle, and swine has changed dramatically to meet the soaring demands for animal proteins in an era where the number of farms raising animals has declined. This increases the likelihood that humans, animals, and birds will share viruses, that those viruses will spread, and that all of us will be susceptible to that spread. The movement of goods and people can also support the movement of vectors, allowing them to become established in new areas.

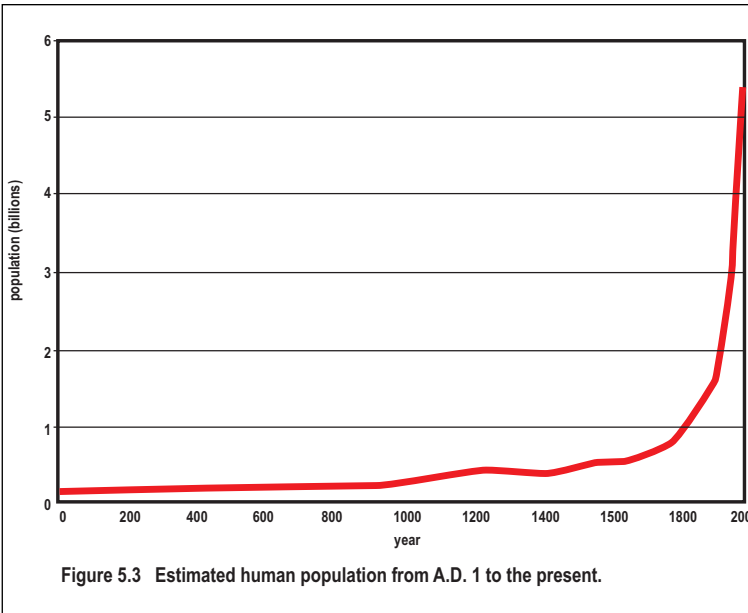
Global health has had great successes: The Rockefeller Foundation made great progress on hookworm and vaccine-preventable diseases. WHO eradicated smallpox and again is close to the eradication of polio. The Carter Center and others are close to the eradication of Guinea worm. Child survival rates are up. Vaccination rates are up. Malnutrition is down. In many ways, these are very good years, in

## How Many People Can the Earth Support?

World GDP/capita 1-2003 A.D.



Science Across The World [English] © ASE 2003



Historical Statistics for The World Economy 1-2003 A.D. © Agnus Maddaloni.

Figure 5.3 Estimated human population from A.D. 1 to the present.





many ways thanks to the vision, not of governments, but of individuals like Bill and Melinda Gates and those who inspired them like Bill Foege. But we are in a different era now because of climate change. We need to do our planning taking into account something which years ago we never considered as essential.

## SECONDARY PREVENTION: SEVEN PRESCRIPTIONS

You have been very kind to indulge my thinking out loud tonight. You've heard my clinical impressions, my diagnosis of the inter-relatedness of climate change, health and welfare, and the stability of our planet and our species.

Climate change will affect the poor and the sick more than the healthy and rich. Health, poverty, and climate change have many inter-related loops. Good health care for children saves lives, parents choose to have fewer children, population growth slows down, the effect on the climate mitigates. The poor try to emerge from poverty through rapid economic development using more energy and consuming more, there is negative pressure on climate, negative effects on sea levels, salting of ground water and agricultural lands, with adverse affects on health and poverty. Hotter winters, fewer insects die off, more vectors survive to carry more diseases. Increased populations of humans leads to increased populations of animals as food sources, with decreased green barriers separating humans and animals leading to more rapid spread of zoonotic diseases. And the cycle will continue until we solve some first order problems.

There may be a question if there is time for primary prevention of climate change, but if we act soon, we still have time for secondary prevention, to make sure that "adaptation" is as palatable as possible. Now if I may be presumptuous I would like to offer seven prescriptions which arise from that analysis.

### **1. Reduce population growth through improving child survival, educating girls, and improving the availability of choices.**

Even though we dodged the bullet of Paul Ehrlich's "population bomb" and it looks like population will top off at around nine to 10 billion people, we eat like there were 20 billion of us, and we underestimated the carbon footprint and environment effects of "only" nine-plus billion of us. The best way to control population is through increasing child survival, educating girls, and making both the knowledge and availability of condoms and birth control

tools ubiquitous. And even better would be to make jobs available for women and make choice a real possibility.

By far the most important of these is increasing child survival. In a community in which childhood death rates hover near one-third, most parents will opt to overshoot their internal targets on their own most desired family size. They will have replacement births, insurance births, lottery births—and the population will soar. It is counter-intuitive, but eradicating smallpox and vaccine-preventable disease and stopping diarrheal diseases and malaria are the best family planning programs yet devised. With fewer childhood deaths, you get lower fertility rates. More disease, especially affecting the poor, will raise infant and child mortality which, in turn, will raise fertility.

I know that the data from Africa appears to contradict the child survival hypothesis. But outside of war torn countries and before the AIDS crisis, almost every sub-Saharan African country dramatically reduced infant and child mortality over the past 40 years. If we go deeper into the data, we see that families who are secure about their children surviving into adulthood opt for dramatically smaller families. And yes, there is a lag time.

We need to intervene to break this cycle. If we don't, everything else will be compounded by soaring population rates.

## **2. Prioritize global health efforts while factoring in climate change.**

We must change the way we think about diseases to factor in the impact and timing of climate change. I used to teach health planning and consult with governments on how to plan their health resources. Looking back, we made plans for a static world. We never thought through planning as if we were adjusting our bow and arrows to allow for the wind. Golfers understand this. Sailors do, too. But from now on, we health planners must understand this. We have to adjust all our planning for the trajectory over time of the effect of global warming.

Triage in medicine is a hard word, usually the hard choice of battlefield medics and emergency room doctors. But we all have to make resource allocation decisions, even if not so dramatic; if we believe that some diseases will be catapulted into dangerous prominence by climate change to become pandemics or explode in virulence, we need to factor that into the risk-cost-benefit decision that health planners make. Nowhere is an ounce of prevention more vital than in the case of communicable diseases. Those diseases that a more careful analysis suggests will become pandemic with a two- to four-degree rise in global temperature need to be adequately



resourced now, including improved alert and surveillance systems. Special emphasis should be placed on mosquito-borne diseases such as malaria, dengue, and Japanese encephalitis; water-borne diseases such as cholera, polio, and Guinea worm; and the emerging zoonotic diseases such as bird flu, etc. If we believe that rising temperatures will spread the risk of malaria to more than a billion new people, we need to put malaria eradication back on the table and do a real gut check on the risks and benefits of using poisons like DDT and other pesticides.

### **3. Increase global disaster preparedness and systems.**

We need to plan for disasters in greater number and of greater severity than we have seen in the past. The trend toward more weather-related disasters such as droughts and floods is clear. The likelihood of novel emerging diseases and new epidemics or pandemics seems high. It is hard to imagine that there will not be increased dislocations and refugees. Less clear is the effect and prevalence of water wars or natural-resource conflicts like Darfur. The Chinese government has reported 230 resource riots per day.

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*We need to plan for disasters in greater number and of greater severity than we have seen in the past. The trend toward more weather-related disasters such as droughts and floods is clear.*

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We need better tools for early warning, for event management, and for collaboration amongst the many and diverse governmental, international, and nongovernmental organizations that constitute the disaster response community. Surveillance must be the first link in the chain of public health action. Most of the surveillance systems for infectious diseases are passive in nature. We need active systems and we need shared systems. One such effort is the INSTEDD consortium funded by the Rockefeller Foundation and Google.org and supported by 100 technology companies and disaster response organizations. If you are interested in this project, you are encouraged to join.

### **4. Address the issue of “peak water.”**

Today we talk about “peak oil.” We need to be talking about peak water. If we were meet-

ing here in 10 years, I don't doubt we would be talking about "peak water." We need a "Manhattan Project" to invent better desalinization methods. To a large degree, the climate crisis is as much about salt as it is about heat. There is a wonderful Urdu expression "namak haram"—to be unfaithful to your salt, to fail to pay heed to the one who gives you salt—something like don't bite the hand that feeds you. But we need to take care not to be unaware of salt's potential devastating effects on water for drinking and growing. Salt has always been a double edged sword—vital for preserving food, deadly for killing the ability to grow it. Roman soldiers were paid partly in salt rations, "salarium argentum"—the forerunner of the English world salary. But in the second century BC, some historians believe the same Roman soldiers sowed the lands of Carthage with salt so it could not sustain agricultural crops to ensure that there would be no sequels to the third Punic War, as the salted land and salted water of Carthage could not sustain raising a new army.<sup>28</sup>

## **5. Adapt agriculture for a brackish world.**

Likewise, we need to invest in agriculture that will survive salted lands, perhaps even if that means bio-engineering of food. We need a Green Revolution in Africa and one that is ready for a brackish world. Rockefeller and Gates have announced major initiatives bringing a Green Revolution to Africa, and how prescient they are.

But just as in anticipating the trajectory of new malaria resurgence, we need to be sure that we don't dismiss genetically modified organisms (GMOs) for purely ideological reasons.

I can't believe I am saying this, and I feel like I am "namak haram" when I speak to you about DDT and GMOs—and I certainly worry about cross fertilization and "letting the genie out of the bottle"; but we have to look objectively at the data, which tell us that our children will inherit a more salty world and we need to have agricultural products that thrive in brackish water.

## **6. Study the unintended consequences of past interventions and learn from them.**

We must be very careful of negative externalities and unintended consequences of well-intentioned interventions. The last green revolution decreased biodiversity. The malaria eradication program in Nepal led to in-migration, cutting down trees, erosion, and flooding which caused devastation in Bangladesh; the banning of DDT in the United States led to a resurgence in malaria deaths worldwide; it is possible that using corn for ethanol fuel instead of for



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food could lead to food shortages. We don't want food scarcity and high prices of grains to be added to the other pressures moving us towards a world where as many as half of us don't have enough food to eat. Pandora's box has been opened by globalization, industrialization and new technology, and human-caused climate change. We need to be careful of what we wish for.

**7. Develop radical new funding methods for secondary prevention, adaptation, or risk mitigation.**

Traditionally, preventive medicine is very difficult to fund, because the rewards of prevention do not return one to one to those who pay for it. HMOs don't like paying for prevention, because they don't know if today's subscriber will still be in their system when they age—so the economic benefit of that pneumonia vaccine will go to the next insurer. It took decades for the primary payer of the costs of tobacco-related disabilities—taxpayers—to understand that they would reap the economic benefits of strong intervention. But there is no better investment than preventive medicine. The eradication of smallpox from the world cost \$150 million and the annual benefits in savings are in the tens or hundreds of billions, but at the time of the campaign it was hard to convince policy makers of the positive externalities. When we eradicate polio worldwide—and we will—the savings from health and disability care in the United States alone are estimated in the tens of billions.

So how do we fund secondary prevention, adaptation, or risk mitigation to reduce the calamitous effects of global warming, particularly on the poorest and most vulnerable people?

First, we have to overcome the disconnects among the health, development, and climate communities. Secondary prevention or risk mitigation requires these to be integrated. In addition to the disconnect between those in the health and the climate crisis communities, there is also a disconnect between those in development and those in climate. The Millennium Ecosystem Assessment clearly showed that we cannot continue to “develop” in ways that

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*Climate change is a development issue.*

*Climate change is a health issue.*

*Climate change is the most urgent threat  
we face from our destruction  
of the earth's natural systems.*

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undermine the planet's natural ability to sustain life.<sup>29</sup> We will not be able to reach the Millennium Development Goals, because it will cost us so much more to engineer the provision of clean water, storm protection, and soil productivity than if we allow nature to do it herself. Development funding must have at its core a focus of restoring our ecosystems, thereby protecting us from all of the consequences I have outlined in this talk tonight.

Climate change is a development issue. Climate change is a health issue. Climate change is the most urgent threat we face from our destruction of the earth's natural systems, and at the same time that we restore the composition of our atmosphere by reducing greenhouse gas emissions, we can also restore other ecosystem functions, thereby alleviating poverty and protecting our health.

Here's how we can do this. Let us move development assistance to prioritize a holistic

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*There is still time for mitigation.*

*There is still time for adaptation.*

*There is still time for prevention.*

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approach to address climate mitigation, adaptation, and otherwise restore our ecosystems. Beyond public financial flows, this must also include the redirection of private sector financial flows—many private financial institutions have adopted new guidelines for more sustainable lending practices,

but these look at mitigating the negative impacts of development projects. What about proactively funding projects that bring development and health improvements while also restoring our natural systems? These projects often take a more creative, locally-driven approach. Some of the best projects I have seen in this arena came from NGOs and small businesses in the developing world at the Development Marketplace of the World Bank: solar water pumping and drip irrigation in Benin; water filtration in Nigeria using the local moringa tree combined with slow-sand filtration; and soil reclamation by cattle ranchers in Bolivia, which also increased their productivity.<sup>30</sup>

Second, let us continue to adjust our own developed-world policies and work with the developing world to jointly deploy clean technologies to market and to create new sustainable businesses. Brazil's ethanol market demonstrates the potential massive upside of cleaner energy approaches—yet even its program has had negative externalities such as pushing soy farming further into the Amazon wildlands, increasing conflicts with indigenous communities.



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Let's learn from the past and build a better, more robust approach for the future. We should not run away from biofuels because of some unacceptable practices such as the rain-forest destruction in Indonesia for palm oil plantations—but let's create market demand for sustainable products by identifying them as such. For instance, when Europe establishes a biodiesel trading platform for moving product to market, let's label and track biofuels to their source and only allow those that meet sustainability criteria to take advantage of that trading platform, penalizing those that use inferior practices. The private sector must be the majority player in meeting these challenges, but capitalism does not yet integrate nature's value, so we have to help it to do so.

Which brings me to cap-and-fair-trade practices. Let's raise the bar on the carbon markets to more holistically benefit the planet and humanity. The world is moving to a more serious response to climate change through cap-and-trade systems. The global carbon markets already move massive flows of capital for climate mitigation. Legislation like California's new law<sup>31</sup> to cap greenhouse gas emissions and similar legislation will allow those flows, again by funding a variety of primary preventive activities: mitigation. The voluntary greenhouse gas credit market has had mixed results even for ensuring the value of the claimed greenhouse gas reductions themselves. But what if some or all of the "grade" or quality of an offset were not only its effect on primary prevention, but on secondary as well—in other words, give extra value for projects that also help those most vulnerable.

And these projects should not be limited to the developing world; our own low-income communities here in the United States have some of the least efficient housing, highest air pollution, greatest vulnerability to increased energy costs, and highest unemployment. Green building projects such as energy efficiency retrofits, renewable energy installations, and green roofs all provide opportunities to reduce greenhouse gas emissions, improve local air quality, and create new jobs—not to mention also lower electricity prices as well as improve student learning and productivity when incorporated into schools and workplaces.

## THE CHALLENGE FOR THE FUTURE

My fellow stewards, we have a lot of work to do. Someone once said that human beings are an evolved species because we, among all animals, know the finitude of our mortal existence. We enter a new world now. And we must do so while preserving the values that we hold



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so dear. There is still time for mitigation. There is still time for adaptation. There is still time for prevention.

I am still optimistic. I think that we have time on our side, not against us, because we can see the trajectory of change. We know that we face difficult choices, but we also know that there are amazing opportunities as there were in the pre-industrial and industrial eras. It took courageous investors to bet on the transcontinental railway and the undersea cable; it will take courageous investors to bet on desalinization technologies, malaria vaccines and better pesticides, childhood vaccination programs, girls' education, and all the primary and secondary preventions—the importance of which society is just beginning to understand.

But there is not a lot of time. My great hope is that there are organizations like NCSE and people like Ambassador Benedick and many others in this room tonight who have spent their lives and careers fighting for the environment in the earlier battles in what is now clearly no less than a war to save our favorite planet.

Thank you for what you have done and what you continue to do. And thank you for allowing me, as a latecomer to this battle, to join you today. It is a distinct honor to be with you.





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## Biography of Senator John H. Chafee

Senator John H. Chafee (R-RI) was born in Providence, Rhode Island, in 1922. He earned degrees from Yale University and Harvard Law School. Upon the United States' entry into World War II, Chafee left Yale to enlist in the Marine Corps, and then served in the original invasion forces at Guadalcanal. In 1951 he was recalled to active duty and commanded a rifle company in Korea.

Chafee began his political career by serving for six years in the Rhode Island House of Representatives, during which time he was elected Minority Leader. He was then elected Governor by a 398-vote margin in 1962. He was re-elected in 1964 and 1966—both times by the largest margins in the state's history. In January 1969 he was appointed Secretary of the Navy and served in that post for three-and-a-half years. He was elected to the United States Senate in 1976.

As Chairman of the Environment and Public Works Committee, the Senator was a leading voice in crafting the Clean Air Act of 1990. He led successful efforts to enact oil spill prevention and response legislation and a bill to strengthen the Safe Drinking Water Act. Senator Chafee was a long-time advocate for wetlands conservation and open space preservation and was the recipient of every major environmental award.

As senior member of the Finance Committee, Senator Chafee worked successfully to expand health care coverage for women and children and to improve community services for people with disabilities. In 1990, Senator Chafee spearheaded the Republican Health Care Task Force. He went on to lead the bipartisan effort to craft a comprehensive health care reform proposal in 1994.

Senator Chafee also was a leader in efforts to reduce the federal budget deficit and co-chaired the centrist coalition that produced a bipartisan balanced budget plan in 1996. He was an active proponent of free trade and was a strong supporter of the North American Free Trade Agreement (NAFTA). He served as Chairman of the Republican Conference for six years.

The Senator received awards and endorsements from such organizations as the National Federation of Independent Business, the American Nurses Association, the League of Conservation Voters, the Sierra Club, Handgun Control Inc., Planned Parenthood, Citizens Against Government Waste, and the National PTA.

On October 24, 1999, Senator John H. Chafee died from congestive heart failure. He is sorely missed.

## Biography of Dr. Larry Brilliant

Larry Brilliant, M.D., M.P.H., is the Executive Director of Google.org. In this role, Larry works with the company's co-founders to define the mission and strategic goals of Google's philanthropic efforts. Google.org, the umbrella organization for these efforts, includes the Google Foundation as well as Google Grants (the AdWords giving program) and the company's major initiatives aimed at reducing global poverty, improving the health of the least advantaged in the world, and working to halt or even reverse the effects of the climate crisis.

Dr. Brilliant is board-certified in preventive medicine and public health. He is a founder and director of the Seva Foundation, which works in dozens of countries around the world, primarily to eliminate preventable and curable blindness. He also serves as a member of strategic advisory committees for the University of California, Berkeley, School of Public Health; Omidyar Network; and Kleiner Perkins (KPCB) Venture Capital.

In addition to his medical career, Dr. Brilliant co-founded The Well, a pioneering virtual community, with Stewart Brand in 1985. He also holds a telecommunications technology patent and has served as CEO of two public companies and other venture-backed start-ups.

The author of two books and dozens of articles on infectious diseases, blindness, and international health policy, Dr. Brilliant has worked at city, county, state, federal, and international levels. He was recently a "first responder" for CDC's smallpox bio-terrorism response effort, volunteered in Sri Lanka for tsunami relief, and established "Pandefense," an interdisciplinary consultancy to prepare for possible pandemic influenza. He lived in India working as a United Nations medical officer for more than a decade, where he played a key role in the successful World Health Organization (WHO) smallpox eradication program, and has recently worked for the WHO polio eradication effort as well. He was associate professor of epidemiology, global health planning, and economic development at the University of Michigan.

Dr. Brilliant earned a Master's in Public Health in health planning and economic development from the University of Michigan and received his M.D. from Wayne University Medical School. He has received several awards from the government of India and from the WHO. In 2005 he received an honorary Doctorate of Sciences from Knox College and was named "International Public Health Hero" by the University of California. In February 2006 he received the Sapling Foundation's Technology Entertainment Design (TED) Prize.

## APPENDIX III

### JOHN H. CHAFEE MEMORIAL LECTURES ON SCIENCE AND THE ENVIRONMENT

2000

**Sherwood Rowland**, Nobel Laureate, University of California, Irvine

**Mario Molina**, Nobel Laureate, Massachusetts Institute of Technology

2001

**Edward O. Wilson**, Pulitzer Prize recipient, Harvard University

2003

**Rita R. Colwell**, Director, National Science Foundation

2004

**Jared M. Diamond**, Pulitzer Prize recipient, University of California, Los Angeles

2005

**William D. Ruckelshaus**, First and Fifth Administrator,

U.S. Environmental Protection Agency

2006

**Ralph J. Cicerone**, President, National Academy of Sciences

2007

**Larry Brilliant**, Founder, Seva Foundation and Executive Director, Google.org

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ISBN 0-9785190-2-7

Printed with Eco-ink (low-volatility vegetable oil-based ink)  
on 25% post-consumer recycled paper using 100% wind energy  
in a carbon neutral process.